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ABSTRACT

The author examines the effectiveness of the Inquiry Strategy method which he hypothesizes to be useful in developing an analytical cognitive style. Ninety-two subjects from four, large urban high schools were involved. Forty-two were experimental, having received 2-3 years of Inquiry Strategy exposure in their late elementary or early junior high years. The other 50 S's were comparisons whose science teaching had been exclusively conventional. From this subject pool, both a longitudinal group and a cross-sectional group were formed. The Sigel Cognitive Style Test was used to assess the subjects' style of categorization. Results indicate that: (1) the Inquiry Process has a significant effect on a student's analytical ability; and (2) these effects are fairly persistent over a period of five or six years. Implications are discussed. (TL)

COGNITIVE STYLE AND INQUIRY STRATEGY: A FIVE-YEAR STUDY*

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The development of the individual's cognitive style has been shown by Kagan, Moss and Sigel (1963) to progress from a relatively global toward a more analytical approach. While this development is a steady, continuous one, a student generally retains his position relative to other students. Thus, cognitive style seems to be somewhat resistant to changes of a wholesale nature in a subject. In accord with this Davis (1967) has reported that efforts to train S's to become analytical in concept identification tasks have not met with success. Yet the author (1966, 1970) has shown that a specific Inquiry Strategy method (Scott, 1962) has apparently made some students more analytical than their agemates who have not received this instructional intervention. It was not clear at this point whether the instructional intervention used effected wholesale and permanent changes in a person's style or not. Both studies were of a cross-sectional design rather than a longitudinal format and there was no way of determining the permanency of these style changes in the studer This current investigation, then aims to deal with the longitudinal effects of the Inquiry Strategy method on the styles of categorization of pupils.

METHOD

The independent variable in this investigation was the Inquiry Strategy method originally conceived by Suchman (1960) and modified by Scott (1964). In this technique the student is presented with a science demonstration that creates a problem situation. His task is to solve a problem by processing information available in the "yes" or "no" answers to the questions he asks the teacher.

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During the course of a session, the student must analyze the situation into its component parts, if he is to be successful in explaining why everything happened the way it did in the demonstration.

The dependent variable was the student's style of categorization, which was assessed by the Sigel Cognitive Style Test (SCST). The SCST consists of two forms: M, (Male) which has twenty cards on each of which are three pictures of familiar objects, such as toys, furniture, fruit and human figures and F, (Female) which has sixteen such cards. The subject's task is to select a pair of pictures from a card and indicate his reasons for the selection. His responses are then coded into one of six categories: descriptive part whole (analytical) descriptive whole (nonanalytical), relational contextual, categorical functional, categorical class-naming and categorical attribute. For the purpose of this study the twelve cards common to both forms were used. Split-half reliability for the twelve cards was .76 (N = 101).

DATA SOURCES

Ninety-two S's from four large, urban high schools were involved in this study. 42 of the S's were experimentals, having received two to three years of Inquiry Strategy exposure in their science classes during their later elementary or early Junior High School years. The remaining 50 S's were comparisons, having received conventional science teaching during the course of their elementary, Junior and Senior High School years. Close questioning of all comparison S's indicated that they had not received at any time during their school experience exposure to the Inquiry process. Likewise, questioning of all the experimentals indicated that they had received none of their instruction in the Inquiry mode at any time since May 1965. All S's were tested with the Sigel Cognitive Style Test (SCST) prior to graduation from High School.

LONGITUDINAL GROUP: The longitudinal group, consisting of 16 experimentals and 16 comparisons, was tested twice; in 1966,* when the students were ending the seventh grade and in 1971, prior to graduation from high school. The comparison S's were from an area, which, in 1966 had a similar socio-economic and cultural background to that of the area in which the experimentals lived. Analysis of the tenth grade achievement test scores for both groups of S's indicated that they were almost equal achievement-wise. Two questions could be answered from the testing program with the longitudinal group:

1) In 1966 were the styles of categorization of Inquiry - exposed students different from students who had received conventional science teaching?
2) If there were any differences in styles of categorization between the two groups of S's in 1966, would these results be stable over a period of five years?

CROSS-SECTIONAL GROUP: The cross-sectional group consisted of 26 experimentals and 34 comparisons and differed from the longitudinal group in that the testing was conducted for both the experimental and comparison S's only one time- prior to high school graduation. The question that could be answered from this testing program was: Were the styles of categorization of the S's exposed to the Inquiry process any different from a cross-section of their classmates prior to high school graduation? In obtaining the 34 comparison S's an effort was made to test groups of students who were comparable to the experimental group in academic ability and achievement. Since this high school was tracking its students, the principal suggested that students in two X classes (high achievement groups) be tested. Analysis of their ability test scores indicated that comparisons had a slight edge over the experimental group. This was due

*In this testing all subjects were administered the original 35 card SCST. However, only data from the same cards as found in forms M and F were pulled from each student's protocol for analysis in this study.

mainly to the fact that most, but not all, experimentals were in X classes. Some were in lower achievement classes. This fact placed the experimentals at a slight disadvantage.

Chi-square was used to test for significant differences between the experimental and comparison groups. A 2x2 contingency table for each of the six SCST categories was constructed with the median score in each SCST category being used to determine the placement of each person's total for a given category. The four cells were: 1) experimentals above the median; 2) experimentals below the median; 3) comparisons above the median; and 4) comparisons below the median.

Null hypotheses were to be tested to determine if there were no significant differences between the experimental and control groups for the six SCST categories. The rejection level was set at .05 or beyond.

RESULTS AND DISCUSSION

The results for the longitudinal groups (Table 1 and Figure 1) indicate that, in 1966, the experimentals were significantly more productive of descriptive part whole labels (analytical) on the SCST than the comparisons ($\chi^2 = 6.13$, $p<.02$). There was no significant difference between the groups for the other five SCST categories. In 1971, the results were about the same, with the experimental group again higher in descriptive part whole labels than the comparison group ($\chi^2 = 5.12$, $p<.03$). These results indicate two things: 1) the Inquiry process has a significant effect on a student's analytical ability and 2) the effects of the Inquiry experience are fairly persistent over a period of five or six years; keep in mind that the experimentals had their last Inquiry lesson in May 1965. The cross-sectional groups (Table 2 and Figure 2) had reportable differences in three of the six

SCST categories. The experimentals once again were more productive in descriptive part whole ($\chi^2 = 6.78$, $p<.01$) and also descriptive whole ($\chi^2 = 4.34$, $p<.05$), and categorical attribute ($\chi^2 = 6.78$, $p<.01$) labels than the comparisons.

One could speculate as to why the cross-sectional group of experimentals had more reportable differences than the group of longitudinal experimentals. The cross-sectional group had more hours of exposure to the Inquiry Method when they were in elementary school than the longitudinal students. Another factor could be that the cross-sectional experimentals were exposed to the Inquiry procedure in grades 5, 6, and 7 while the longitudinal experienced it in grades 4, 5, and 6. It could be that grades 6 and 7, particularly, are prime times in the student's developmental continuum and that the introduction of the Inquiry methodology at this point has a greater impact per minute of instructional time than in grades 5 and 6, for example.

Since the results for the descriptive part-whole category are consistent across both the longitudinal and cross-sectional groups, apparently, the Inquiry Strategy Method influences a student's ability to classify objects through a descriptive part-whole (or analytical) preference.

IMPLICATIONS

Of what value is the analytical behavior? Since the experimental subjects in this study have apparently been influenced by the Inquiry procedure to categorize analytically, and this influence has persisted, that question does need answering. Several investigators have reported findings pertinent to this point. Kagan et. al (1964) have stated that there is a positive correlation for fourth grade boys between analytic concepts and the tendency to

analyze geometric stimuli into distinct figural and background components. Frederick (1968) has reported that analytical S's show higher school achievement in English, Social Studies and Mathematics. An investigation by Kagan (1965) indicated that analytic-reflective boys of primary school age had fewer reading problems than non-analytical impulsive boys. The development of an analytical ability, then, has implications for achievement in the school setting. Since the analytical student has a predisposition to reflect on the relevant and irrelevant items of information arrayed before him, he can more easily extract the important things for his interpretation than can a globally oriented subject. Thus, he has a set-related behavior that will allow him to solve problems with complex stimuli; e.g., geometrical problem situations which contain lines and angles, many of which are irrelevant to the problem solution and some of which are necessary to the understanding of the important relation[illegible]n the problem. In chemistry, it is also important for the student, when faced with complex chemical formulas depicting reactions, to analyze the entire set of stimuli before he can predict the changes that were (or are) taking place.

Logic and research both indicate that an analytically-oriented learner is more efficient than the non-analytical student in many tasks, especially those disciplines such as mathematics and the sciences, where analysis and reflective behavior are potent tools for success. On the other hand, creativity and productivity in areas such as the arts and humanities could be handicapped in a person with an analytical and reflective set. A study by Lee et. al. (1963) reinforces this notion. They found that non-analytic S's acquired concepts that did not require analysis much easier than the analytic S's. At this point further research is in order so that the total impact of the Inquiry process on students can be assessed. An in-depth study of the academic performance of these students is needed to discover what aspects of their school activities contain deficiencies, as well as to verify the aforementioned proficiencies.

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TABLE I

SUMMARY OF CHI-SQUARE VALUES FOR LONGITUDINAL GROUPS

SCST	1966 Testing		1971 Testing	
CATEGORY	χ^2	p	χ^2	p
Descriptive, Part-Whole (analytical)	6.13	<.02	5.12	<.03
Descriptive Whole (global)	<1.00	-	<1.00	-
Relational Contextual	<1.00	-	<1.00	-
Categorical Functional	<1.00	-	<1.00	-
Categorical, Class Naming	1.13	-	<1.00	-
Categorical Attribute	0.00	-	0.00	-

TABLE II

SUMMARY OF CHI-SQUARE VALUES FOR CROSS-SECTIONAL GROUPS

SCST		
CATEGORY	χ^2	p
Descriptive, Part-whole (analytical)	6.78	<.01
Descriptive Whole (global)	4.34	<.05
Relational Contextual	<1.00	-
Categorical Functional	<1.00	-
Categorical, Class naming	0.00	-
Categorical Attribute	6.78	<,01

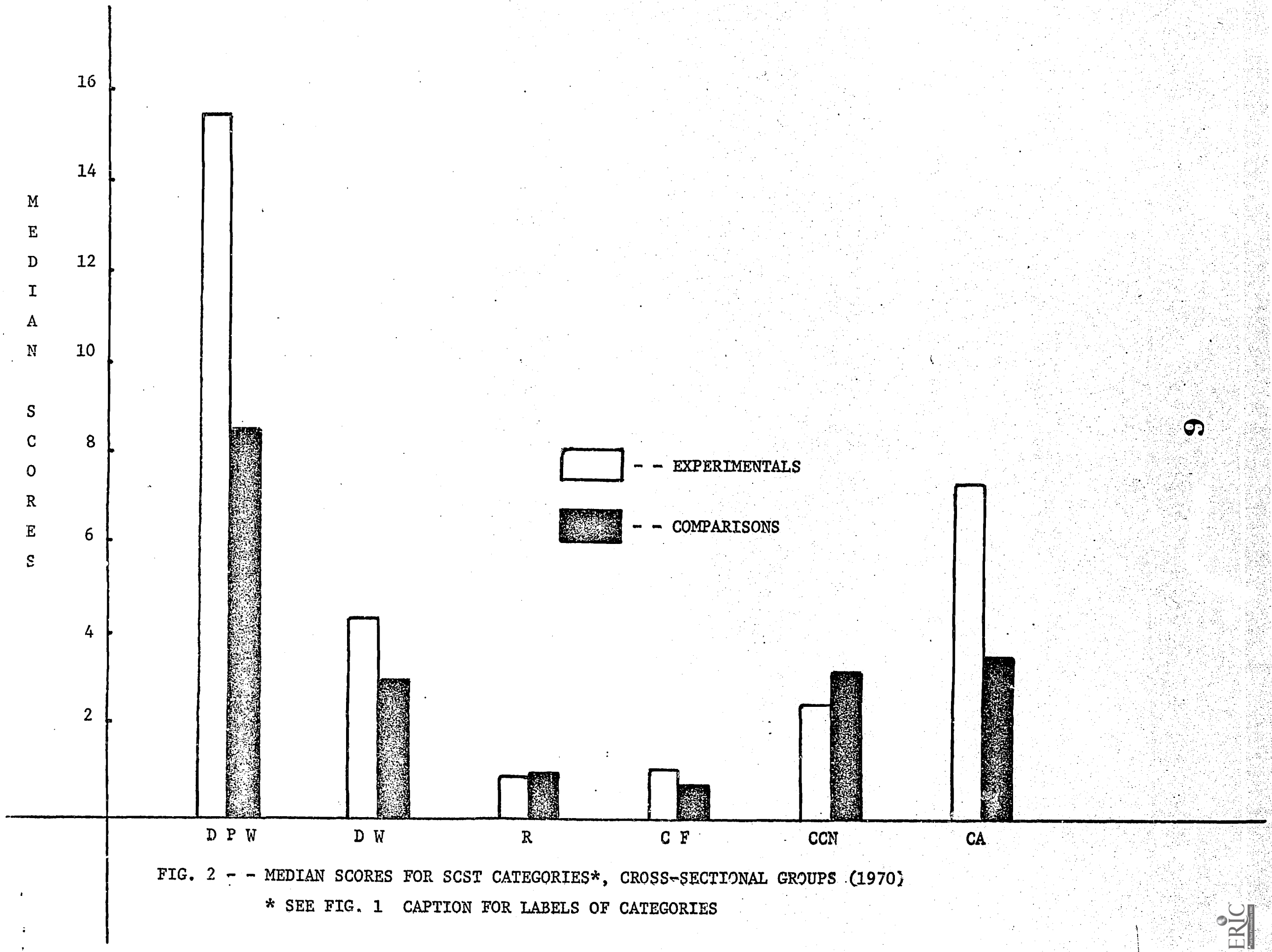

FIG. 2 - - MEDIAN SCORES FOR SCST CATEGORIES*, CROSS-SECTIONAL GROUPS (1970)

* SEE FIG. 1 CAPTION FOR LABELS OF CATEGORIES

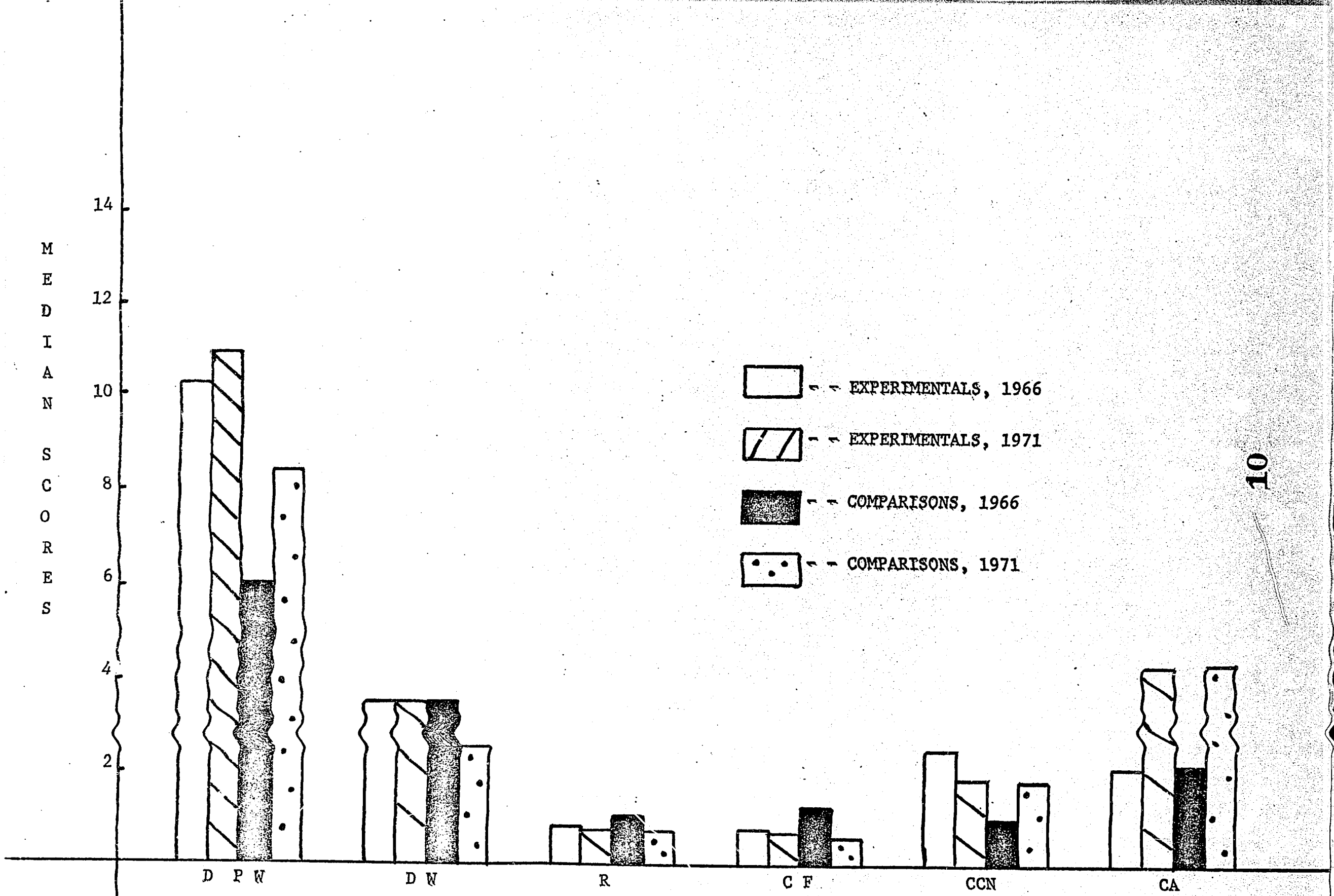

FIG. 1 -- MEDIAN SCORES FOR SCST CATEGORIES*, LONGITUDINAL GROUPS

*DPW = DESCRIPTIVE, PART-WHOLE; DW = DESCRIPTIVE WHOLE; R = RELATIONAL CONTEXTUAL; CF = CATEGORICAL FUNCTIONAL
CCN = CATEGORICAL, CLASS NAMING; CA = CATEGORICAL ATTRIBUTE